# DEVELOPMENT AND PERFORMANCE EVALUATION OF A CHAPATI PRESSING MACHINE

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# DECLARATION

We hereby declare that this project report entitled **"Development and Performance Evaluation of Chapati Pressing Machine"** is a *bonafide* record of project work done by us during the course of project and that the report has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title of any other University or Society.

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## CERTIFICATE

Certified that this project report, **"Development and Performance Evaluation of Chapati Pressing Machine"** is a record of project work done by **Ms. Akhila J Chand (2012-06-001), Ms. Rasmi Janardhanan (2012-06-009), Mr. Sanad S (2012-06-010), Ms. Sandhya K R (2012-06-012)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship.

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# SYMBOLS AND ABBREVATIONS

| | |
|---|---|
| = | Equal to |
| / | Divided by |
| X | Multiplication |
| ± | Plus or minus |
| : | Ratio |
| % | Percentage |
| AC | Alternating current |
| Agric. | Agricultural |
| Chem. | Chemistry |
| Cm | Centimeter |
| DC | Direct current |
| Engng | Engineering |
| *et al.* | and others |
| Eur. | European |
| F & APE | Food and agricultural process engineering |
| Fd | Food |
| g | Gram |
| GO | Glucose oxidase |
| Hp | Horsepower |

| | |
|---|---|
| HPMC | Hydroxyl propyl methyl cellulose |
| Hum. | Human |
| Hz | Hertz |
| ie. | That is |
| Ind. | Industry |
| Int. | International |
| J. | Journal |
| KCAET | Kelappaji College of Agricultural Engineering and Technology |
| kg | Kilogram |
| Mg | Milligram |
| ml | Milliliter |
| Mm | Millimeter |
| MS | Mild steel |
| MT | Metric ton |
| No. | Number |
| Nutr. | Nutrition |
| Pakist. | Pakistan |
| pp. | Page number |
| Res. | Research |
| Rpm | rotations per minute |

| | |
|---|---|
| s | Second |
| Sci. | Science |
| Sl | Serial |
| Stud. | Studies |
| Technol. | Technology |
| USA | United States of America |
| V | Volt |
| W | watts |
| w.b | Wet basis |
| A.P. | Andhra Pradesh |

# ***Introduction***

# CHAPTER 1

# INTRODUCTION

Wheat is a major cereal in India. Wheat is unique in the sense that large numbers of end-use products such as Chapati, bread, biscuits, noodles and pasta products are made from it. Wheat is a cereal grain, originally from the Levant region of the Near East but now cultivated worldwide. In 2013, world production of wheat was 713 million tons, making it the third most-produced cereal after maize and rice. 720 Metric tons of wheat was produced in the year 2015 - 2016.

As traditional staple foods in India, chapati and poories stand next only to cooked rice. In northern parts of the country chapati and poories are the main staple foods. All preparatory operations are carried out manually, which is tedious and time consuming. Attempts to produce and market pre-cooked and packed fast foods; especially Chapati are being made by some agencies with very little success, one of the problems in their attempts being the non availability of suitable machinery for preparing them on a large scale. In case a device is made available for making Chapati would result in reduction in labour and drudgery to cater to large number of people in short time in serving Chapati of uniform quality. The mechanization would pave way for the production and marketing of precooked and packed Chapati as convenient food in large volumes hygienically.

A variety of breads have been developed from wheat, which is the main staple food in India. The term is hardly appropriate for a numerous roasted, fried and baked items of India. Dry baked forms of roti include the common chapati, baked dry on a hot plate, sometimes puffed out to pulka by brief contact with live coal or flame. A very thin Chapati prepared in Gujarat state is called rotlee. The rumali roti is also thin but much bigger in size. The Bhatia made in the state of Rajastan are soft, thin rotis that come apart as two circles because of the style of rolling of the dough. Dough carrying spinach yield distinctive rotis, the missiroti, baked dry on a tava, flaky in texture has spinach, green chillies and onions in the dough. The kakras are kneaded with milk and water is crisp product that keeps well for longer period and is carried by Gujarati travelers.

Wheat products after rolling out can be either pan baked using a little fat, or baked without fat. Paratas are the most common, often square or triangular in shape rather than circular. The dough can be mixed with seasoned vegetables like potatoes, spinach or methi and these products are eaten with curd. Poories are deep fried products made from wheat flour and sometimes the dough is mixed with sugar or fat. The dough of bhatura is allowed to ferment using yogurt, and then rolled out to give a layered fried product.

The other category of the wheat based product which re unleavened and baked, either in closed or heated oven or in Indian style tandoors, which are open, lined, glowing ovens with live coals placed at the bottom. Naan is made of Maida, the white inner flour of wheat, which is leavened before baking to yield a thick elastic product. Nan is normally dressed with either saffron water or tomato to give red surface colour after baking.

Paratha is an important part of a traditional South Asian breakfast. It is unleavened flat bread and they are making by baking whole wheat dough on a tava, and finishing off with shallow frying. Paratha are thicker and more substantial than chapatis and this is either because, in the case of a pain paratha, they have been layered by coating with oil or ghee and folding repeatedly. Parathas can be eaten as a breakfast dish or as a tea – time snack. The flour used is finely ground whole meal (atta) and the dough is shallow fried. They are several types of parathas are available like aalooparatha, aaloo cheese paratha, andaparatha, balwalaparatha etc.

Naan is a well known kind of flat bread. A typical naan recipe involves mixing white flour with salt, a yeast culture and enough yogurts to make smooth, elastic dough. Raisins and spices can be added to the bread to add to the flavor. Naan can also be covered with, or serves as a wrap for various toppings of meat, vegetables or cheeses.

Rumali roti is thin flat bread popular in India and in Pakistan. The word rumal means handkerchief and this name is derived because of its structure like that. This bread is extremely thin and staple and the fact that it is usually served as folded like a handkerchief. This is usually made with a combination of whole and white wheat flours (atta and maida) and cooked on top of an inverted Indian griddle.

Khakhras are thin crackers made from mat bean, wheat flour and oil. It is served usually during breakfast. They are individually hand-made and roasted to provide a delicious, crunchy and healthy snack enjoyed with selection of pickles and chutneys. Khakhra is made in several varieties such as methi, bajri, math and masala etc.

Rotis and chapatis are the staple food in India and different type of these unleavened breads are prepared from wheat are baked on a steel plate and puffed by bringing in contact with live flame for a brief period. Chapati, normally hand rolled by a pin and plate are baked on pan using fat. Chapati is prepared by sheeting the dough to about 1.5 mm thickness and cutting it into 150 mm diameter discs (Shurpalekar and Prabhavati, 1976).

Chapati making is a bit difficult process because the dough has to be primarily kneaded manually, followed by sheeting into a definite diameter and then baking it. The major portion of the dough is composed of wheat protein, gluten, which is sticky in nature. The stickiness of the dough is the major difficulty, which leads to the drudgery in kneading of the dough, in day to day life. Without the adequate composition of flour to water ratio the consistency of the dough will not be apt for the preparation of chapati. The dough will stick to the fingers of the person kneading the dough and the utensils if the composition is not perfect. The sheeting process is also in itself a difficulty since correct roundness and correct thickness of the chapati has to be attained while sheeting otherwise the texture of the baked chapati will not be as anticipated by the consumer. Flattening and sheeting of the dough is one of the most crucial steps in flat bread production and small variations in thickness changes bread quality significantly. Flattening of dough is done by pressing / rolling or sheeting methods. In sheeting method, dough pieces or extruded dough is repeatedly passed under pressing rollers to form flat dough of required thickness. Therefore production of chapati is a difficult process.

Chapati dough is typically prepared with Atta, salt and water, kneaded with the knuckles of the hand made into a fist and left to prove for at least ten, fifteen minutes to an hour for the gluten in the dough to develop. After proving, the dough becomes softer and more pliable. Small portions of the dough are pinched off and formed into round balls that are pressed between the two palms to form discs which are then dipped into flour and rolled out on a circular rolling board chakla using a rolling pin into a perfect circle.

The rolled-out dough is then thrown on the preheated dry tava and cooked on both sides. In some regions of South Asia chapatis are only partly cooked on the skillet, and then put directly on a high flame, which makes them blow up like a balloon. The hot air cooks the chapati rapidly from the inside. In some parts of northern India and eastern Pakistan, this is called a phulka. It is also possible to puff up the roti directly on the tava. Once cooked, chapati is often topped with butter or ghee.

The drudgery in production of chapati presents the need for development of mechanical devices. An enhanced capacity can be achieved by using machinery for production of the same. Manual production of chapati was found to be of very lower efficiency, since the number of chapatis produced per hour will be very low compared to mechanized production. The efficiency in the preparation of chapati can also be improved by using machinery in this field. Chapatis of uniform size and shape can also be produced. Also the production economics could be improved

Though some chapati making machines are available in market they are exorbitantly priced and complex in its make. The maintenance of such automatic, continuous machines are also difficult. Therefore, it becomes necessary to device machineries for chapati pressing which is simple in operation, easy to maintain and suiTable for small scale industries, Kudumbhasree's and self help groups to purchase. With this in mind, this project was taken up with the following objectives:

1. To develop a simple, semi mechanical chapati pressing machine which is easy to operate, maintain and economical.

2. To evaluate the performance of the developed machine.

# ***Review of Literature***

# Chapter 2

# REVIEW OF LITERATURE

This chapter reviews the research and developments that had taken place in wheat science and technology and related activities, machineries for making pressed dough products.

## 2.1. Wheat

Wheat is a major cereal in India and is consumed mainly in the form of unleavened flat bread known as Chapati (Prabhasankar, 2002). Chapati is usually prepared from whole-wheat flour and the desired quality parameters in Chapati are greater pliability, soft texture, light creamish brown colour, slight chewiness and baked wheat aroma (Haridas *et al*., 1986).

Wheat is unique in the sense that large numbers of end-use products such as Chapati, bread, biscuits, noodles and pasta products are made from it. This is possible because of viscoelastic property imparted to the dough by its gluten proteins. Grain texture, gluten constituents and starch composition in the endosperm are major determinants of end-product quality. Molecular markers for these components have been identified, and are being used in breeding for the improvement of wheat quality. Transgenic approach will be helpful in manipulating metabolic pathways for enhancing micronutrient bioavailability and increased lysine content (Sewa *et al*., 2001).

Lazaridou *et al*. (2007) studied the effect of hydrocolloids on dough rheology and bread quality parameters in gluten-free formulations based on rice flour, cornstarch, and sodium caseanate. Addition of xanthan to the gluten-free formulation resulted in a farinograph curve typical of wheat flour doughs. The type and extent of influence on bread quality was also dependent on the specific hydrocolloid used and its supplementation level.

Hardeep and Cristina (2004) conducted a study on improvement of the bread making quality of rice flour by glucose oxidase was conducted by GO modified the rice flour proteins by lowering the thiol and amino group concentration. The addition of GO promoted an increase in the elastic and viscous modulus. Rice bread with better specific volume and texture was obtained with GO addition allowing the decrease of the hydroxyl-propyl-methylcellulose (HPMC) levels in the rice bread recipe.

Kaur *et al*. (1989) studied the organoleptic acceptability of chapatis made from combination of durum and aestivum wheat supplemented at different levels with Bengal gram flour and soy protein concentrate. Chapatis made from fortified wheat flour with defatted soy flour were acceptable but those made from rapeseed and sunflower seed flours were unacceptable (Jain *et al*., 2000).

**2.2. Gluten**

Wheat is consumed in many different forms, mainly as chapati, bread, noodles, macaroni, spaghetti, cakes, pizzas, and doughnuts. The ability of wheat flour to be processed into different foods is largely determined by the gluten proteins (Weegels *et al*., 1996).

The gluten proteins constitute up to 80% to 85% of total flour protein, and confer properties of elasticity and extensibility that are essential for functionality of wheat flours (Shewry and Tatham, 1994).

Gluten proteins, representing the major protein fraction of the starchy endosperm, are predominantly responsible for the unique position of wheat amongst cereals. These form a continuous proteinaceous matrix in the cells of the mature dry grain and form a continuous viscoelastic network during the mixing process of dough development. These viscoelastic properties underline the utilization of wheat to prepare bread and other wheat flour based foodstuffs (Faqir and Saeed, 2007).

The gluten proteins consist of glutenin, responsible for elasticity of dough and gliadins, for providing extensibility to dough (Gianibelli *et al*., 2001; Maucher *et al*., 2009).

Gluten can be prepared by gently washing dough under a stream of running water. This removes the bulk of the soluble and particulate matter and leaves a proteinaceous mass that retains its cohesiveness on stretching. Gluten comprises some 75% protein on a dry weight basis. The vast majority of the proteins are of a single type called prolamins, which were initially defined based on their solubility in alcohol–water mixtures (Osborne, 1924).

The viscoelastic property of dough, which influences the baking quality of wheat flour, depends on the quality and quantity of protein. Thus, the ideal wheat cultivar for chapati making should have protein content between 10 and 13% (Austin and Hanslas, 1983).

**2.3. Chapati**

Chapati is an unleavened, circular-baked product prepared from whole-wheat flour, which is the staple food of a majority of the population in many regions of the Indian subcontinent and parts of the Middle East (Nurul and Johansen, 1987). About 80 to 85% of the total wheat produced in the country is used for the preparation of chapati (Misra, 1998).

Traditionally, chapatis are flatbreads made from atta (Indian wheat flour). Elasticity of doughs is important for stabilizing bubbles during rolling and baking and atta dough are low in strain-hardening but high in elasticity and retain bubbles the best after baking. Lupins can be used to increase elasticity of Australian wheat flour dough and to make gluten-free chapatis (Chakrabarti *et al*., 2013).

Wheat with good chapati-making quality exhibited distinct electrophoretic pattern (Prabhasankar, 2002). The qualitative differences in wheat proteins appear to outweigh quantitative differences in determining baking quality.

It is found that chapatis made from some composite flours showed higher extensibility even after 24 h of storage, especially barley. Some of the additives like wet gluten and sodium caseinate also significantly improved the texture of chapati (Hardeep and Ambika, 2002).

Effect of spinach powder on the physico-chemical, rheological, nutritional and sensory characteristics on chapati premixes was studied and it was found that peak viscosity, breakdown viscosity significantly decreases whereas, peak time, tenacity increases with the increase in the concentration of spinach powder (Khan *et al*., 2015).

Different wheat varieties were screened for chapati making characteristics, and it is found that arabinose to xylose ratio was higher in varieties having good chapati making quality compared to poor varieties in the flour and barium hydroxide extract, which are rich in arabinoxylan type polysaccharides. The ratio of xylose to glucose was higher in good Chapati making varieties compared to poor varieties (Revanappa *et al*., 2007).

Vidya *et al.* (2012) studied the effect of thermal treatment on selected cereals and millets flour doughs and their baking quality. It is found that raw rice and finger millet doughs were associated with the high extent of instrumental and sensory stickiness. Thermally treated pearl millet and sorghum doughs were the best followed by treated rice and finger millet samples to give the desirable dough characteristics, and were quite close to wheat chapati in texture.

Traditional Indian unleavened bread (chapati) was prepared by incorporating wheat bran (insoluble fiber) and oat bran (soluble fiber) at different levels into whole wheat flour. Based on compromise optimization, it is recommended to incorporate 5.5 g wheat bran and 9.7 g oat bran per 100 g flour for making optimally acceptable fiber rich chapati (Yadav *et al*., 2010).

Sridhar and Manohar (2001) conducted a study on optimization of the continuously extruded unleavened flat bread. Processing variables such as size of die openings, production rate and initial moisture content on the discharge temperature and power input used in the continuous production of Indian unleavened flat bread (chapati) were studied. The optimum conditions are found to be a rate of 40 kg/h, a die opening of 1.4 mm height 200 mm width and moisture contents of 60% and 75% (w.b) for resultant Atta and Atta, respectively.

Maya and Haridas (1990) found that steaming of flours at atmospheric pressure for 15 min completely denatured the gluten and reduced the water absorption capacity from 58.4% to 45.0%.

Srilatha and Krishna (1997) studied the proximate composition and protein quality evaluation of recipes containing sunflower cake. It is found that incorporation of sunflower cake into recipes at 10 and 20 percent levels contributed a significant increase in protein and fibre values. Digestibility coefficient of pakodi containing partially dehulled sunflower cake was 89 percent and that with whole seed cake was 86 percent.

Staling will have to be controlled to retain the soft, pliable texture of chapatis, thereby ensuring consumer acceptability. Staling in chapatis occurs largely because of retrogradation of gelatinized starch (Rao *et al*., 1986).

During staling, moisture was released from starch and taken up by gluten (Katz, 1928). Senti and Dimler (1960) studied the equilibrium relative humidity, and suggested that moisture transfer occurred from starch to gluten.

Optimal thicknesses for atta dough have been reported to be in the range 2 - 2.5 mm for obtaining fully puffed, soft and pliable chapatis (Rao *et al*., 1986). Although dough sheets of less than 1 mm thickness puffed fully, their eating qualities were unacceptable. At thicknesses greater than 2.5 mm, chapatis had under-baked qualities.

**2.4. Machinery**

There are few reports of developments of machinery for Indian traditional foods. Some of the machines designed and developed are continuous chapati machine based on screw extrusion and three tier baking oven (Gupta *et al*., 1990).

A review of the status of machinery for Indian traditional foods and a need for mechanization with emphasis on reduced processing cost with hygiene for the Indian food machinery manufactures has been presented (Ramesh, 2004).

Gurushree *et al.* (2011) conducted a study on the design, development and performance evaluation of chapati press cum vermicelli extruder and found that the quality of chapatis was not adversely affected as a result of mechanical pressing. Combined machine produced more numbers of chapatis as machine press time per chapati was 12s compared to 29s of manual sheeting time. Appearance quality characteristics of vermicelli indicated smooth and uniform surface characteristics. Sensory evaluation of the cooked vermicelli indicated no significant difference.

# ***Materials and Methods***

# CHAPTER 3

# MATERIALS AND METHODS

This chapter deals with the material used methodology opted for the development and evaluation of a chapati press. A conceptual design was conceived and then the machine was fabricated in the workshop at KCAET, Tavanur.

## 3.1. EXPERIMENTAL PROCEDURE

### 3.1.1. Raw Material:

Chapati flour procured from the market was used for making chapatis. Dough mixes of different flour water ratios were formulated to see the best ratio for efficient chapati making without sticking and deformations.

Table3.1. Dough water ratio

| Sl. no. | Samples | Flour (g) | Water (ml) | Flour water ratio |
|---|---|---|---|---|
| 1 | A | 200 | 132 | 10:6.6 |
| 2 | B | 200 | 125 | 8:5 |
| 3 | C | 200 | 120 | 5:3 |

### 3.1.2. Preparation of dough:

The flour is mixed with water, kneaded properly till the correct consistency is reached. The flour was weighed and three samples of 200 g each were weighed. Dough mixes were made by adding measured quantity of water to the weighed flour samples as described in Table3.1. All the three samples were manually kneaded till the correct consistency of the dough was reached (Fig3.1.). The best consistency was found noting the minimum stickiness. Dough was rolled into rolls of 50 g. The best consistency of dough was noted.

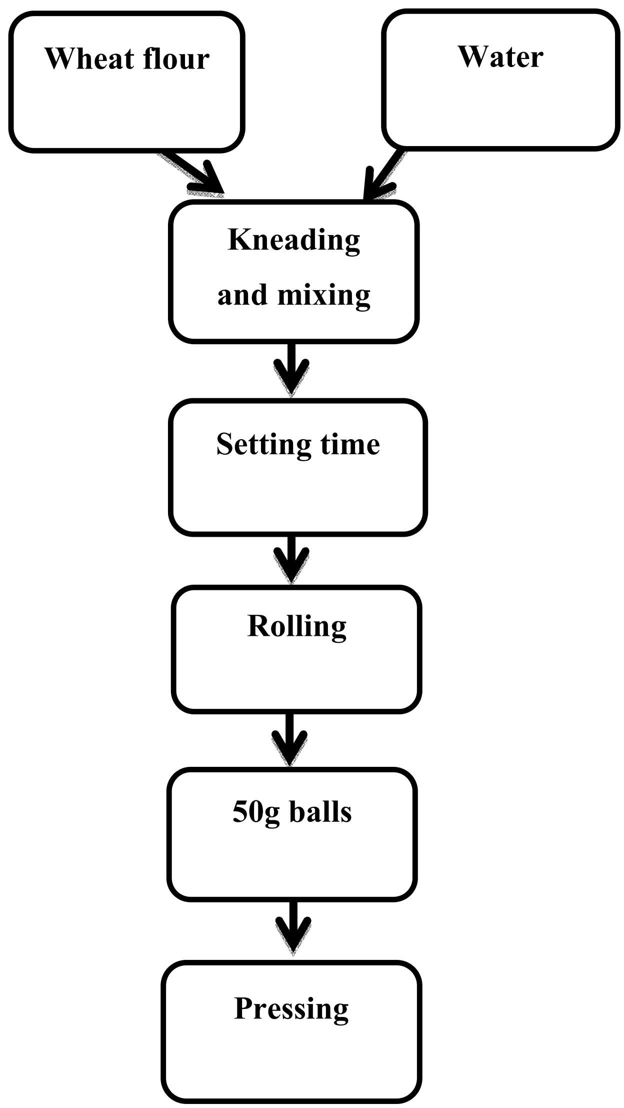


Fig3.1. Dough preparation

### 3.1.3. Development of Chapati Pressing Machine

Chapati pressing machine was developed and fabricated in the workshop of Kelappaji College of Agricultural Engineering and Technology, Tavanur. It consists of a frame, power drive and a pressing mechanism.

#### *3.1.3.1. Frame*

Frame is used to provide support to bear the load and minimize vibration and ensure stability to the machine. Frame consists of 8 mild steel L-angles, cut and welded. The L-angles were of a thickness of 5 mm. The angle used was of 35 mm x 35 mm dimension. The frame has a dimension of height 540 mm, length 500 mm, width 510 mm. Four angles were welded on the frame to provide support, at a height of 66 mm above the ground, on the vertical angles. Angles were again welded on the support 135 mm above the ground to act as supports for the gear box. An angle on the top of frame and another angle placed 100 mm from it provides the support for the motor.

Plate3.1. Frame

### *3.1.3.2. Power Drive and Transmission*

#### *3.1.3.2.1. Motor*

An electric motor is an electrical machine that converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor.

A single phase motor of power 0.5 hp with a speed of 1420 rpm and a frequency of 50 Hz was used as the prime mover for the operation. The motor was placed 540 mm above the ground on the frame. The speed was reduced by employing a belt, chain, gear box and a pulley mechanism. Single phase AC motor was used with a voltage range of 200-220 V.

Plate3.2. Electric Motor

#### *3.1.3.2.2. Gear Box*

A gearbox is a mechanical method of transferring energy from one device to another and is used to increase torque while reducing speed. Torque is the power generated through the bending or twisting of a solid material. This term is often used interchangeably with transmission.

Located at the junction point of a power shaft, the gearbox is often used to create a right angle change in direction. The gear ratio used is designed to provide the level of force required.

In a situation where multiple speeds are needed, a transmission with multiple gears can be used to increase torque while slowing down the output speed. The same principle can be used to create an overdrive gear that increases output speed while decreasing torque.

In the chapati pressing machine developed, the gear box was fixed 13.5 cm above the ground and has a power reduction ratio of 30:1. From the motor a 2 inch pulley was connected to a 12 inch pulley on the gearbox using a 44 B V-belt. On the gearbox a sprocket of 6 inch was attached which is then connected using a chain to a 12 inch sprocket at height of 30.5 cm from the smaller sprocket.

Plate3.3. Gear box

***3.1.3.2.3. Belt Drive***

A belt and pulley system is characterised by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realised.

The torque obtained depends on the belt's resistance to the applied tension and the degree of adherence to the inner walls of the pulley groove. For this reason, belt-drive systems should never be lubricated, as they depend on friction to transmit power, in contrast to chain or gear systems that function through pure contact pressure. The inside face of the belt should never touch the bottom of the groove.

For the transmission of the power from the motor, a 2 inch pulley was attached to the motor. The 2 inch pulley is connected to a 12 inch pulley on the gearbox using a 44 B V-belt.

***3.1.3.2.4. Chain drive***

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of machines.

Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered.

On the gearbox a sprocket of 6 inch is attached which is then connected using a chain to a 12 inch sprocket at height of 305 mm from the smaller sprocket.

Plate3.4. Sprocket and chain attachment

### *3.1.3.3. Cam*

A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion or vice versa. It is often a part of a rotating wheel or shaft that strikes a lever at one or more points on its circular path.

In the mechanism fabricated, the cam is a circular plate of 300 mm diameter, with the stroke length adjusting mechanism welded along with it. From the sprocket the power was transmitted to the cam using a shaft of 25 mm diameter and of 320 mm length. At the cam the stroke length required for providing the adequate load was set and noted. A shaft of 25 mm diameter and of 240 mm length is guided through the support bored with a hole of 26 mm and the rotating motion provided to the cam was converted into reciprocating motion of the shaft connected to the plates or pressing.

Stroke length is the distance the shaft moves while striking. The stroke length can be adjusted by moving the clamping mechanism back and forth along the diameter of the cam. And the most adequate stroke length which is required for the production of the required load is measured and noted. Two flat mild steel rectangular pieces 5mm thick and 60 mm wide kept 124 mm apart from the diameter of the circular plate was used to act as the guide for the stroke length adjusting mechanism. A 125 mm rod of diameter 18 mm was clamped between the flat pieces. The rod was threaded for a length 35 mm so that it could be tightened by a square flat piece of MS of 45 mm x 45 mm dimension. The required stroke length was adjusted and tightened according to the need. The shaft from the cam was connected to the 125 mm long rod, clamped to the circular plate, by a hollow cylinder of diameter 21 mm and length 25 mm. The hollow cylinder was welded to a movable clamp of length 34 mm which had a groove of 15 mm in it. A shaft of 25 mm diameter and of 240 mm length was guided through the support, 400 mm from the ground, bored with a hole of 26 mm and the rotating motion provided to the cam was converted into reciprocating motion of the shaft connected to the plates or pressing. This shaft was attached to the clamp at the top and bottom by nut and bolt. The shaft was cut into a thickness of 10 mm at each end for a length of 20 mm on both sides.

Plate3.5. Cam

### *3.1.3.4. Pressing Mechanism*

When the sprocket rotates, the shaft of length 320mm parallel to the width of the frame, tightened on the top of the frame by two pillow blocks of internal diameter 25mm, rotates. The rotational motion of the shaft is converted into reciprocating motion at the cam which was then transmitted to the shaft of length 240mm, connected to the plates. The end of the shaft was cut into a projection which fit into the groove on the plates, made using two mild steel pieces welded on the plates, so that the reciprocating motion was transmitted to the plate, which provided the force for pressing the plates, and therefore the chapatis were pressed into regular rounds. The diameter of the plate was 17 cm. The plate on the top was welded with four 70 mm long flat mild steel pieces so that swaying motion of the top plate during its reciprocating motion was prevented. The bottom plate was locked between the two supports, L angles across the frame provided at a height of 210 mm from the ground for supporting the plates. The plate was rotated so that the groove at the bottom of the plate fell in the orientation necessary for locking the plate on the support. A rectangular MS piece, welded on the bottom plate, of dimension 80 mm x 70 mm x 7.5 mm acted as the platform for the locking mechanism which is a flat MS piece of dimension 147 mm x 23 mm x 8 mm. The plate was coated with ceramic coating to improve the texture and geometry of chapatis.

Plate3.6. Pressing mechanism

(A) (B)

Plate3.7. (A) Bottom plate (B) Ceramic coating on the plate

## 3.2. OPERATIONAL PROCEDURE

The machine works on single phase AC electricity, 220 - 230 V voltage. A single phase motor of power 0.5 hp at a speed of 1420 rpm and a frequency of 50 Hz was used as the prime mover for the operation. The motor was placed 540 mm above the ground on the frame. The speed was reduced by employing a belt, chain, gear box and a pulley mechanism. The prime mover motor was connected to the input electricity so that electric current would be converted into mechanical energy. From the motor a 2 inch pulley was connected to a 12 inch pulley on the gearbox using a 52 B V-belt. The gear box had a speed reduction ratio of 30:1. On the gearbox a sprocket of 6 inch was attached which was then connected, using a chain, to a 12 inch sprocket at height of 30.5 cm from the smaller sprocket.

The Cam was used to convert rotating motion of the shaft to reciprocating motion of the press by which the dough was pressed into sheet easily. It was a circular plate of 300mm diameter, with the stroke length adjusting mechanism welded along with it. From the sprocket the power is transmitted to the cam using a shaft of 25 mm diameter and of length 320mm. At the cam the stroke length providing the adequate load was set and a shaft of 25 mm could be guided through the support bored with a hole of 26 mm and the rotating motion provided to the cam was converted into reciprocating motion of the shaft connected to the plates or pressing.

From the prime mover power was transmitted using the belt drive to the gear box wherein the speed was reduced and load was provided. The rotational motion is transmitted from the gear box to a shaft, parallel to the width of the frame. The rotational motion of the shaft was then converted into reciprocating motion at the cam which was then transmitted to the shaft connected to the plates. The end of the shaft was cut into a projection which fits into the groove on the plates so that the reciprocating motion was transmitted to the plates enabling the chapati to be pressed between plates.

3.3. PERFORMANCE EVALUATION OF THE DEVELOPED MACHINE

The dough was prepared as the mentioned in the above section 3.1.2. The machine was fabricated as per the conceptual design and the operational procedure as discussed in the section 3.1. Performance of the machine was evaluated in terms of capacity, power, and efficiency.

**3.3.1. Watt meter**

The power consumption of the developed machine was found out using a watt meter. The details of the connection of the watt meter to the machine are shown in the Plate3.8.

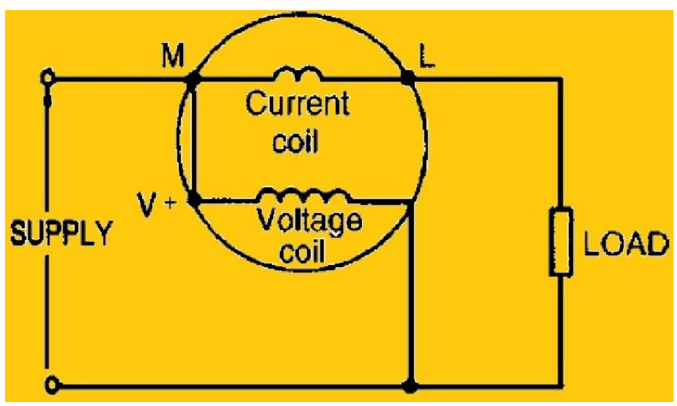


Plate3.8. Watt meter circuit

'M' it connect one is voltage phase of mains and 'M' to 'C' are inter connect. 'L' it is used to connect load 'C' it is a common terminal is a support device. The dial shows the readings directly. The machine is connected as the load and the AC input is provided as the supply.

### 3.3.2. Capacity Measurement

The capacity of the chapati pressing machine is the number of chapatis which can be pressed by the machine in one hour. It was found out by preparing 6 chapatis in the machine and the time required for the preparation of the samples was noted. Capacity of the machine was found out using the formula given below.

$$\text{Capacity} = \frac{(\text{No. of samples produced x 60})}{\text{time taken for the production}}$$

### 3.3.3 Efficiency Measurement

The efficiency of the machine was measured by taking into consideration the attributes of the produced chapatis. The chapatis produced were inspected for the presence of deformation in their shape, ie. whether the chapatis had a distorted diameter, higher than average thickness of chapatis available in market, which was found to be 1.5 mm. In order to find out the efficiency 30 chapatis were made using the machine. The torn, deformed and the chapatis with thickness greater than 1.5 mm were separated and noted.

The efficiency was calculated using the formula given below

$$\text{Efficiency} = \frac{(\text{No. of good chapatis } \times 100)}{\text{Total time taken for production}}$$

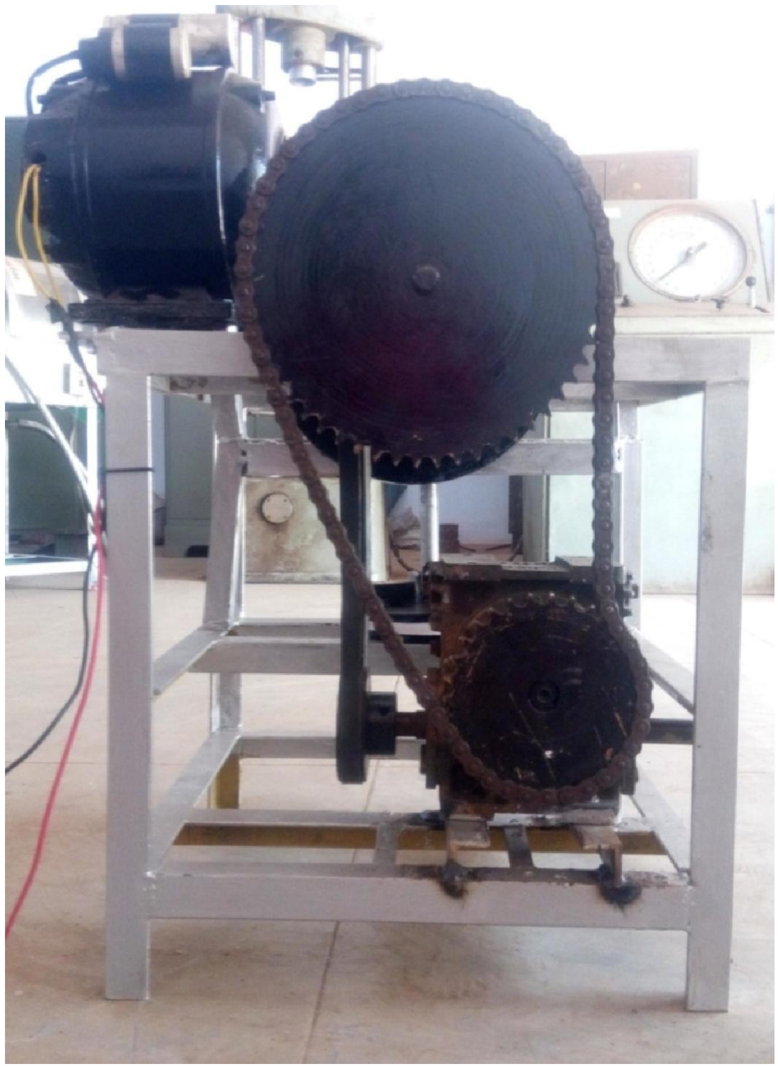

Plate3.9. Front view of chapati pressing machine

Plate3.10. Side view of chapati pressing machine

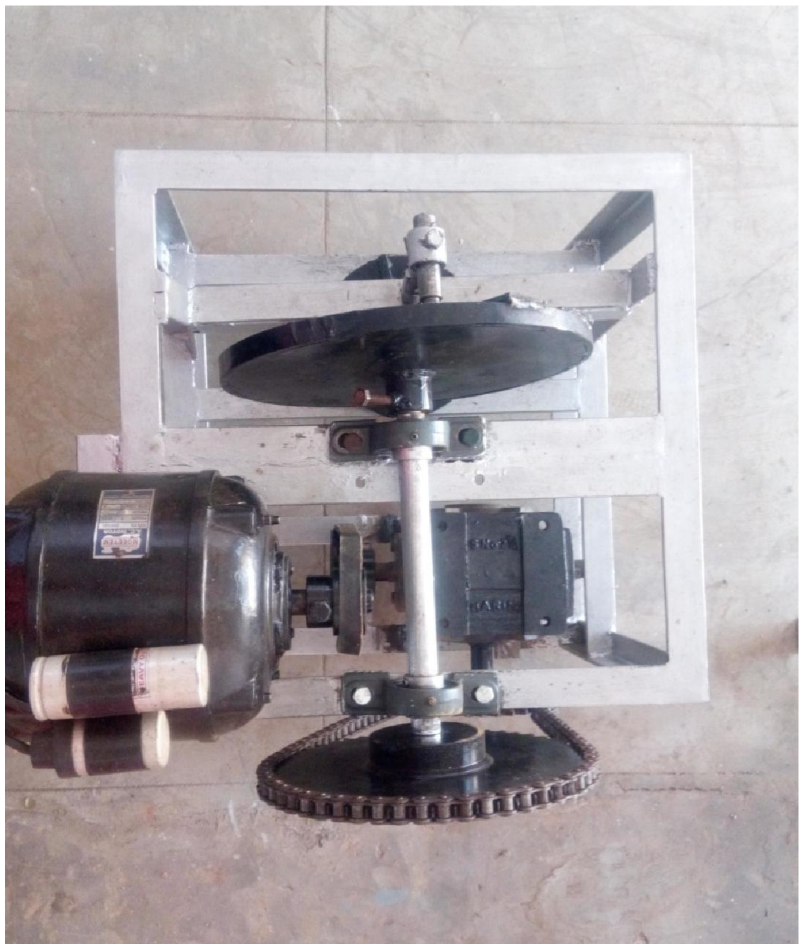

Plate3.11. Top view of chapati pressing machine

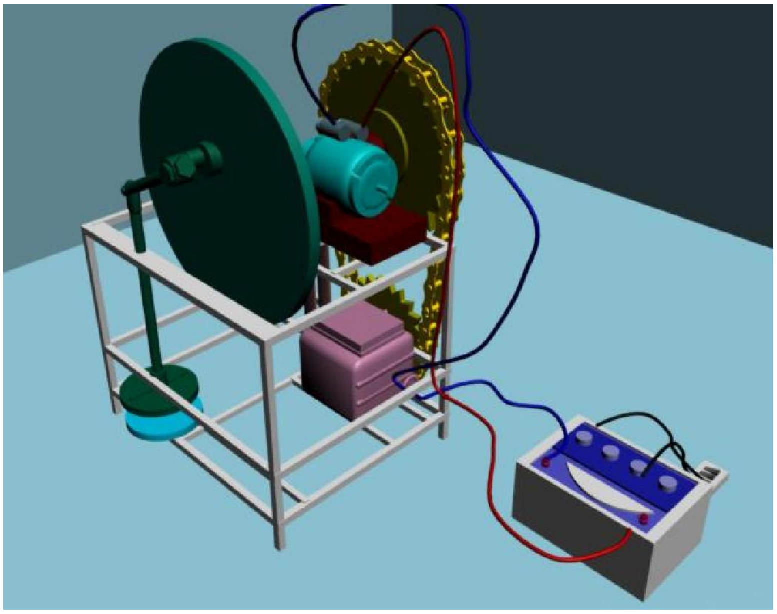

Plate3.12. Schematic isometric view of chapati pressing machine

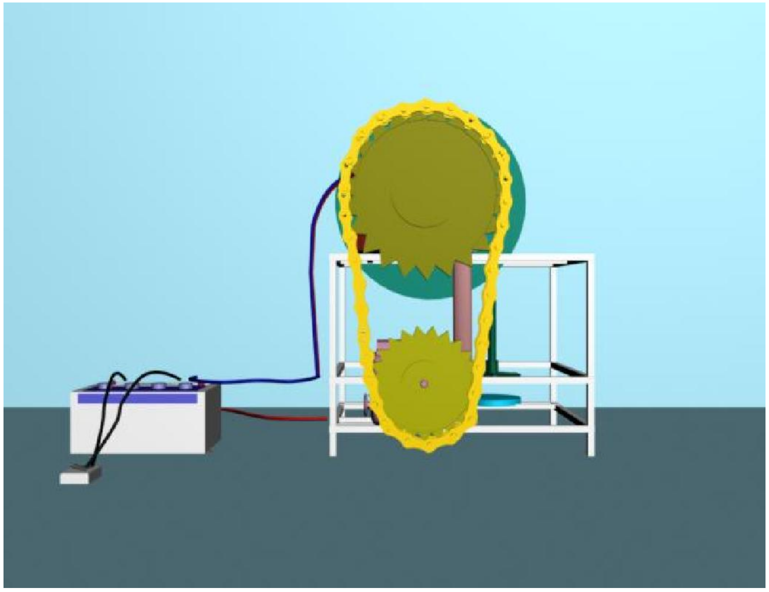

Plate3.13. Schematic front view of chapati pressing machine

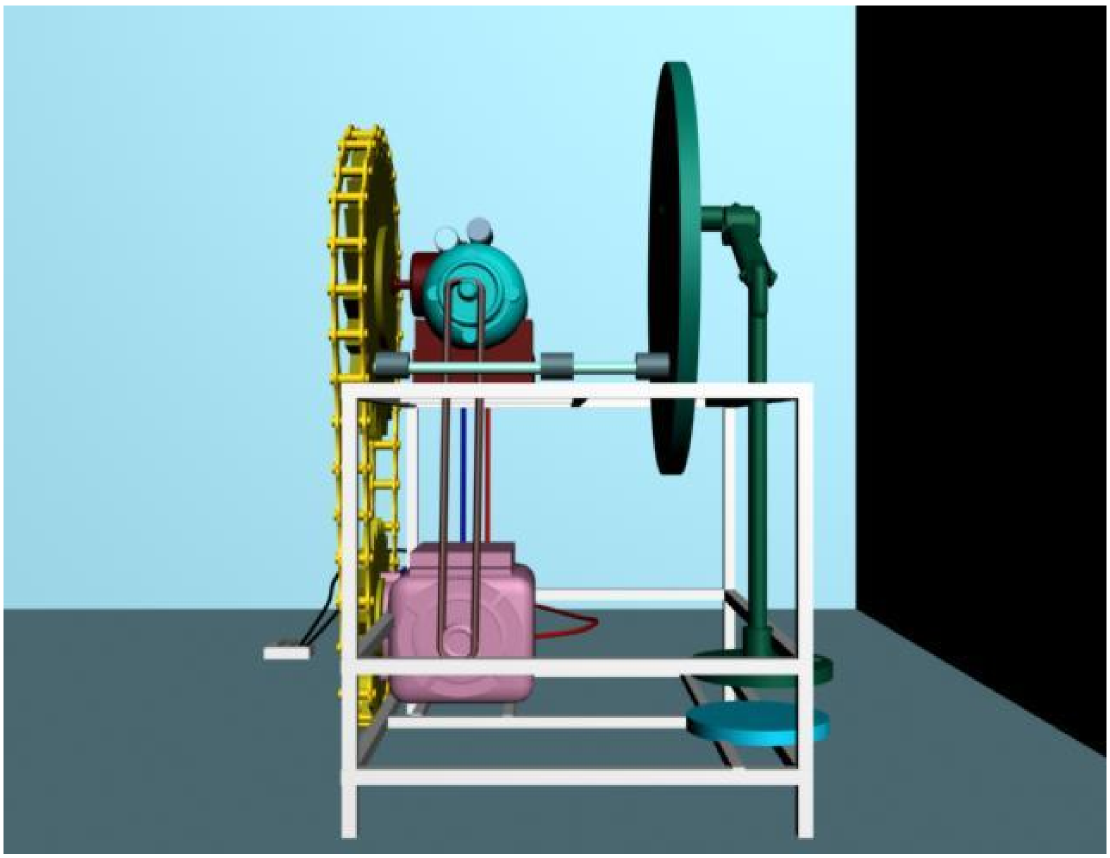

Plate3.14. Schematic side view of chapati pressing machine

# ***Results and Discussion***

# 4. RESULTS AND DISCUSSION

This chapter deals with the results of the experiments carried out to evaluate the performance of the Chapati Pressing Machine.

## 4.1. Selection of Dough Mix

It was found that the machine worked efficiently at a dough mix for sample A, 200g flour and 132 ml water with a flour water ratio of 10:6.6. At other compositions of dough the machine did not provide efficient pressing, the machine could not withstand the load at varying compositions. Ghurushree *et al*. (2011) reported that, the dough for chapatis and vermicelli, to be pressed in a chapati press cum vermicelli extruder, was prepared by mixing 500 g of whole wheat flour with the predetermined amount of water 325 ml.

## 4.2. Power Requirement

The power was found out using a watt meter. It is connected to the machine as mentioned in the above section 3.3.1.

Plate4.1. Watt meter connected to the machine

It was found that the average power requirement for the operation of the chapati pressing machine was 300 W.

### 4.3. Capacity of the Machine

It was found that for pressing a chapati 40 seconds were required in the machine. The capacity of the machine was found to be 45 chapatis / hr.

### 4.5. Specifications of the Pressed Chapatis

Table4.1. Specifications of the pressed chapatis

| Chapati sample | Diameter(cm) | Thickness (mm) |
|---|---|---|
| i | 13.5 | 1 |
| ii | 13 | 1.4 |
| iii | 14.5 | 0.5 |
| iv | 14.5 | 0.5 |
| v | 14 | 0.9 |
| vi | 14.5 | 0.5 |

The dimension of the pressed chapati obtained using the machine is shown in Table4.1. The results indicated that there was no significant difference in diameters and thickness of the samples. The average thickness of chapati pressed was found to be 0.8 ± 0.6 mm, and the average diameter was found to be 13.8 ± 0.8 mm. The chapatis pressed were smooth and of uniform surface characteristics. The cooked chapatis too had very good aroma and the texture of the chapati was similar to manually rolled chapatis.

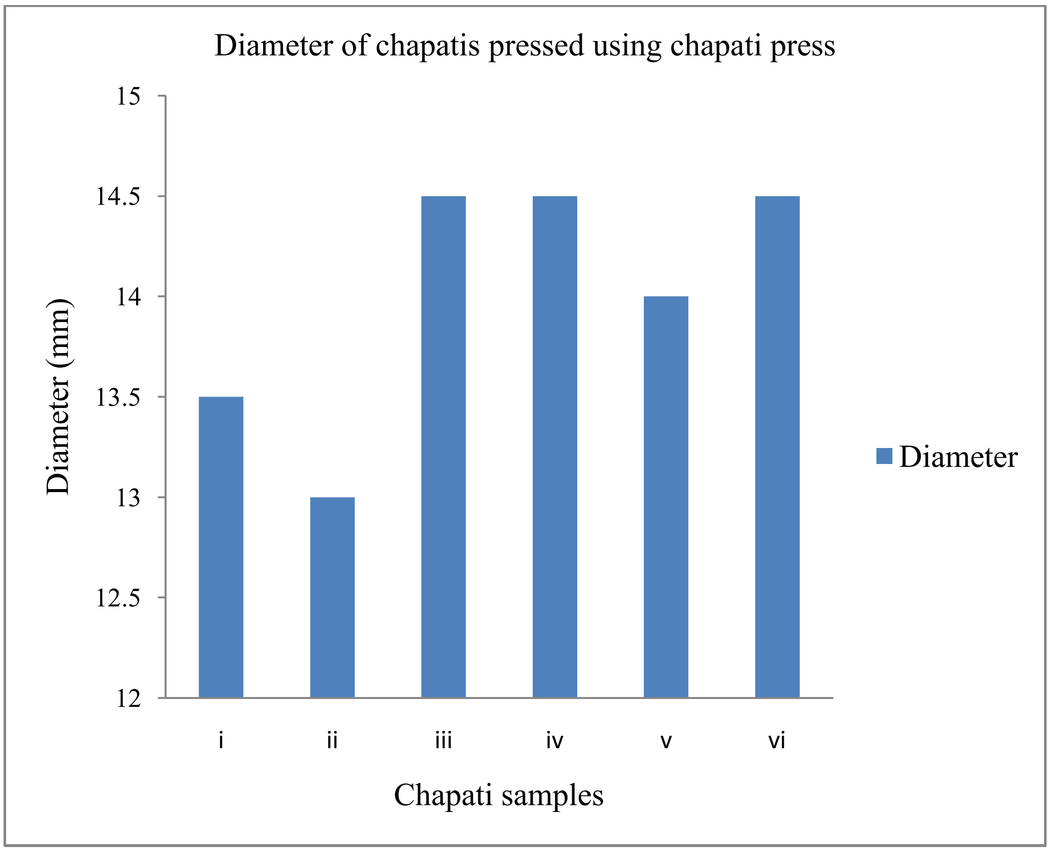


Fig.4.1. Diameter of pressed chapatis

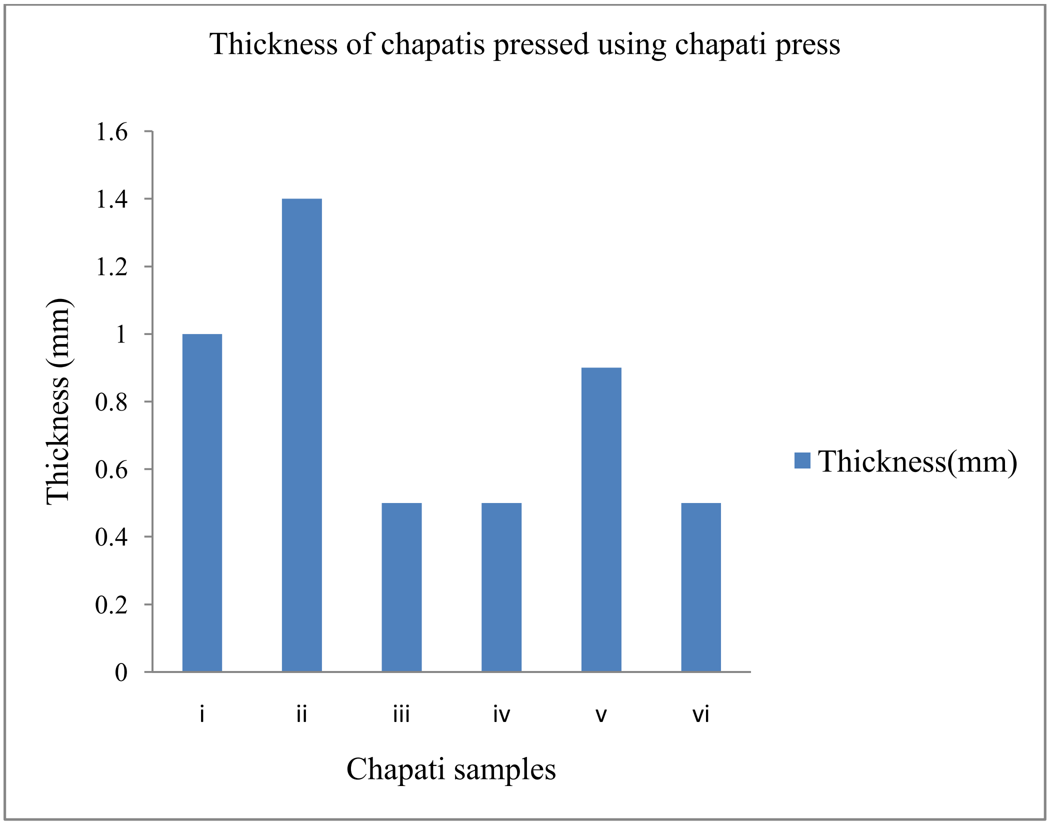


Fig.4.2. Thickness of chapatis presssed

Plate4.2. Chapati samples pressed in the machine

Plate4.3. Cooked chapatis pressed using the developed machine

**4.5. Stroke Length of the Machine**

The machine worked efficiently with efficient pressing at a stroke length adjusted to 32.5 cm from the centre of the cam, when the stroke length adjusting mechanism was adjusted 3.5 cm below the centre of the cam. At other stroke lengths, the machine did not effectively press the dough nor was the required load for efficient pressing obtained.

**4.6. Efficiency**

Efficiency was calculated. Thereby chapatis were prepared in the machine and it was found that one among them had distortion in roundness; one stuck to the plates and was torn while removing it from the plates and one was found torn. So the efficiency was found to be 90%.

**4.7. Analysis of the prepared chapati**

The prepared chapatis had very good aroma and the texture of the chapatis were similar to manually rolled and cooked chapatis. The mouth feel and taste of the cooked chapatis were similar to the manually prepared chapatis.

# ***Summary and Conclusion***

## 5. SUMMARY AND CONCLUSION

Chapatis are the staple food in India and different type of these unleavened breads are prepared from wheat are baked on a steel plate and puffed by bringing in contact with live flame for a brief period. Chapati making is a bit difficult process because the dough has to be primarily kneaded manually, followed by sheeting into a definite diameter and then baking it. Without the adequate composition of flour to water ratio the consistency of the dough will not be apt for the preparation of chapati. Flattening and sheeting of the dough is one of the most crucial steps in flat bread production and small variations in thickness changes bread quality significantly.

The drudgery in production of chapati presents the need for development machinery in this field. Machineries for kneading, pressing, continuous kneading - pressing - baking automatic machinery have been developed and can be further developed and modified to decrease the drudgery in this field. Though some chapati making machines are available in market they are exorbitantly priced and complex in its make. The maintenance of such automatic, continuous machines are also difficult. Therefore, it becomes necessary to device machineries for chapati pressing which is simple in operation, easy to maintain and suitable for small scale industries, Kudumbhasree's and self-help groups to purchase. With this in mind, this project was taken up to develop a simple, semi mechanical chapati pressing machine which is easy to operate, maintain and economical and to evaluate the performance of the developed machine.

A chapati pressing machine was developed and fabricated which consists of a frame, power drive, power transmission mechanism and a pressing mechanism. Frame was constructed to provide support to bear the load. An electric motor was provided for producing rotating motion which was transmitted through a gear box to set a 30:1 speed reduction and a belt and chain drive to a cam which converted the rotary motion to reciprocating motion. A shaft was used to transmit the power to the plate which presses the chapati into sheets on another plate.

The dough of optimum consistency was pressed using the chapati pressing machine and the performance evaluation was also carried out. The developed machine was found to have a capacity of 45 chapatis per hour and the power requirement was 300 W. The machine worked efficiently at a dough mix of 200g flour and 132 ml water ie. a flour water ratio of 10:6.6. At other compositions of dough water ratio, the machine did not provide efficient pressing, as it could not withstand the load. The stroke length was adjusted to 32.5 cm from the centre of the cam. The average thickness of the pressed chapati was about 0.8 mm and the average diameter was about 13.8 mm. The average time taken for chapati pressing is about 80s for a single chapati. The power requirement was found to be 300 W. The observed variation in thickness and diameter from chapati to chapati was of the order of ± 0.6 mm and ± 0.8 mm respectively. It was found that there was no significant difference in diameter and thickness of the chapatis made. The pressed chapatis indicated smooth and uniform surface characteristics. The cooked chapatis had good aroma and texture similar to that of manually prepared chapatis.

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# ***Appendices***

# APPENDIX I

| Sl. No. | Nutrient | Quantity (per 100 g) |
|---|---|---|
| 1 | Carbohydrate | 46.3 g |
| 2 | Sugar | 2.72 g |
| 3 | Fat | 4.75 g |
| 4 | Dietary fiber | 4.9 g |
| 5 | Protein | 11.25 g |
| 6 | Thiamine | 0.55 mg |
| 7 | Niacin | 6.78 mg |

# APPENDIX II

| Particular/Year | 2013-14 (MT) | 2014-15 (MT) | 2015-16 (MT) |
|---|---|---|---|
| Production | 714 | 720 | 720 |
| Trade | 156 | 143 | 148 |
| Consumption | 696 | 707 | 716 |
| Carry Over Stock | 188 | 202 | 206 |

# DEVELOPMENT AND PERFORMANCE EVALUATION OF A CHAPATI PRESSING MACHINE

**By**

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**SANDHYA K R**

**ABSTRACT OF THE PROJECT REPORT**

**Submitted in partial fulfillment of the**

**requirement for the degree of**

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***IN***

***FOOD ENGINEERING***

**Faculty of Agricultural Engineering and Technology**

**Kerala Agricultural University**

***Department of Food and Agricultural Process Engineering***

**KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING & TECHNOLOGY**

**TAVANUR P.O.-679573, KERALA, INDIA**

**2015**

## ABSTRACT

Simple, semi mechanical chapati pressing machine which is easy to operate, maintain and economical was fabricated. The developed machine was found to have a capacity of 45 chapatis per hour and the power requirement was 300 W. The machine worked efficiently at a flour water ratio of 10:6.6. At other compositions of dough water ratio, the machine did not provide efficient pressing, as it could not withstand the load. The stroke length was adjusted to 32.5 cm from the centre of the cam. The average thickness of the pressed chapati was about 0.8 mm and the average diameter was about 13.8 mm. The average time taken for chapati pressing is about 80s for a single chapati. The power requirement was found to be 300 W. The observed variation in thickness and diameter from chapati to chapati was of the order of ± 0.6 mm and ± 0.8 mm respectively. It was found that there was no significant difference in diameter and thickness of the chapatis made. The pressed chapatis indicated smooth and uniform surface characteristics. The cooked chapatis had good aroma and texture similar to that of manually prepared chapatis.